5. Greenhouse gas abatement in Asia: imperatives, incentives and equity

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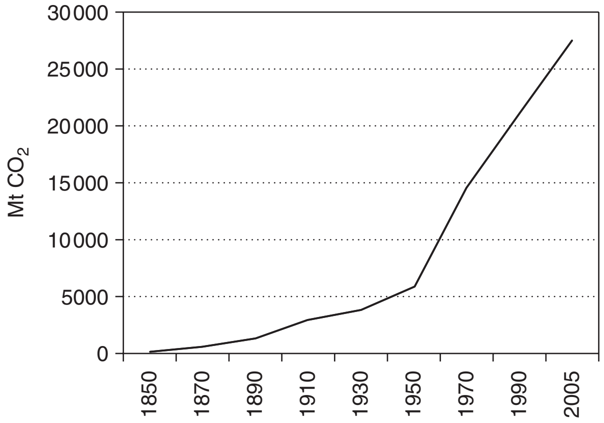
5.1 INTRODUCTION: EMISSIONS TRENDS IN DEVELOPING AND ASIAN COUNTRIES

5.1.1 Global Trends

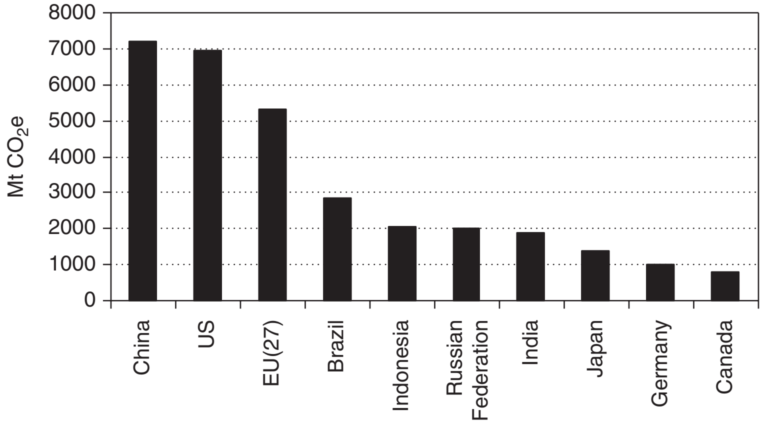
Human-induced global warming is mainly a result of heat being trapped in the atmosphere by greenhouse gases (GHGs) that have accumulated due to the burning of fossil fuels since the beginning of the Industrial Revolution, together with the clearing of forests to make way for agriculture (see Figure 5.1). The concentration of the main greenhouse gas, carbon dioxide (CO_2), which is very long-lived in the atmosphere, is 35 per cent higher than it was in 1850.

The top ten emitting countries (with the inclusion of the European



Source: WRI (2010a).

Figure 5.1 *CO_2 emissions from fossil fuel combustion, annual, 1850–2005*



Note: LUC emissions are indicative only in many developing countries (see Appendix 5.1) but are included because they make up a large proportion of some of those countries' emissions, and because LUC is responsible for 12 per cent of total global emissions.

Source: WRI (2010a).

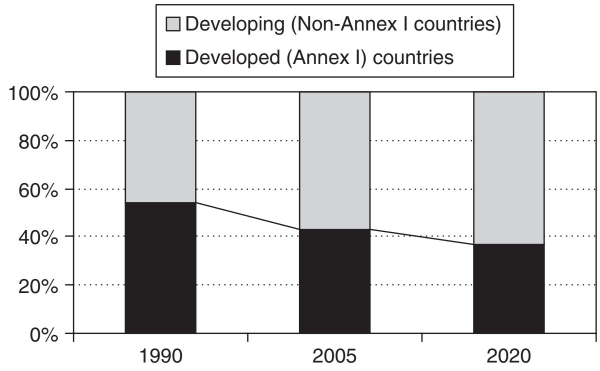
Figure 5.2 Top ten emitters of CO_2e, with land-use change, 2005

Union (EU)) were responsible for 70 per cent of global emissions of carbon dioxide equivalent (CO_2e) in 2005 (see Figure 5.2).[1] Five of the top ten are developing countries and four of these are in Asia, China being ranked first and Indonesia, India and Malaysia, fourth, seventh and ninth respectively.

The GHG emissions of developing countries increased by 57 per cent from 1990 to 2005 and those of Asian countries almost doubled due to their industrialisation and rapid economic growth. In contrast, emissions of developed countries remained static.[2] Developing countries now emit greater quantities of GHGs than developed countries and their contribution is forecast to increase to some 63 per cent of global emissions by 2020 (see Figure 5.3).

5.1.2 Trends in Asia

China, Indonesia and India are collectively responsible for over a quarter of contemporary CO_2e emissions. But while the emissions of China and India are overwhelmingly due to energy generation, Indonesia's are mainly due to land-use change; that is the release of carbon from biomass due to native forest harvesting and native forest replacement by agriculture. There are also large difference in emission per capita and trends in emission intensity between countries. The inter-country difference in



Source: Appendix Table A5.2.

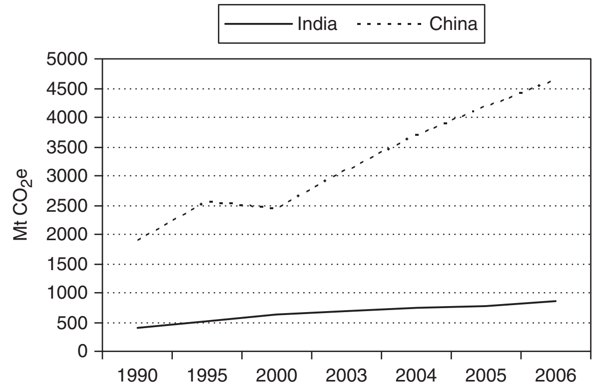
Figure 5.3 GHG (CO_2e) emissions actual and projected

sources signals that approaches to mitigation of GHGs in Indonesia will be very different to approaches in China and India, the implications of which are further discussed below.

The correlation between the size of a country's economy and its level of GHG emissions is very high for Asian countries and higher than for the rest of the world.[3] Developed countries have been lowering their emission intensity by switching from coal to gas in electricity and heat generation. In contrast, in developing countries the share of coal in electricity and heat generation increased from 43 per cent in 1992 to 52 per cent in 2006 (IEA 2008a).

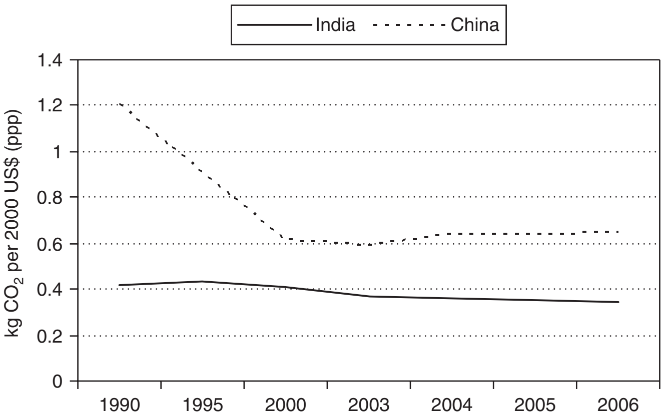
In China, the demand for electricity has been responsible for an exponential rise in GHG emissions in recent years. Rapid expansion of heavy industry to service large infrastructure investment has been accompanied by an increasing demand for Chinese products domestically and by overseas consumers. Electricity demand was stimulated to such an extent that new capacity was being added at the rate of two coal-fired power plants per week (China Electricity Council 2007, cited by IEA 2008a). As a consequence of the increasing share of coal in power generation, the Chinese economy, responsible for almost 20 per cent of global GHG emissions, became less – rather than more – emissions-efficient from 2002 to 2006. (See Figures 5.4 and 5.5).

While inefficient coal-fired plants are being shut down and the use of natural gas is increasing, coal is forecast to maintain its market share for the foreseeable future and, therefore, its share of emissions from fuel combustion of 83 per cent (IEA 2008a, B165; IEA 2008b, p. 145).[4] Like China, India has experienced rapid economic growth, accompanied by an upward trend in emissions from the heat and electricity sector. As a consequence, India



Source: IEA (2008a).

Figure 5.4 China and India: CO_2 emissions from coal, 1990–2006



Source: IEA (2008a).

Figure 5.5 China and India: emissions intensity, 1990–2006

is now responsible for almost 5 per cent of global emissions from energy generation. However, while 68 per cent of India's electricity generation still comes from coal, the share of fossil fuels has declined steadily, as have emissions per unit of gross domestic product (GDP), as it expanded its renewable power capacity (IEA 2008a, p. xxix). Figures 5.4 and 5.5 contrast China and India for their level of emissions from coal, and emissions intensity.

In Indonesia considerable economic benefits flow from conversion of forest to crops, principally oil palm. Beneficiaries are loggers, farmers, oil processors, merchants and the Indonesian and regional governments (Hunt 2010). This conversion is a classical case of market failure in that the climate, environmental and biodiversity benefits of conserving the forest are non-market benefits and have no bearing on the commercial decisions to replace forest with agriculture. The increasing demand for palm oil seems inexorable, being driven by world population growth and higher disposable incomes.

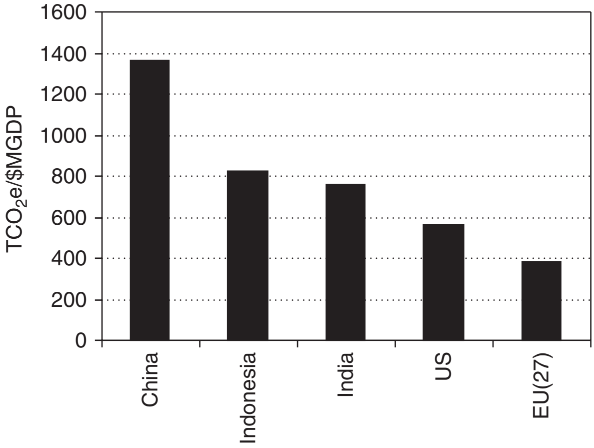
5.2 COSTS AND BENEFITS OF MITIGATION IN ASIAN COUNTRIES

5.2.1 Climatic Impacts on Asia Under a Business As Usual (BAU) Scenario

The Intergovernmental Panel on Climate Change (IPCC) (2007) summarised the impacts of climate change on Asia as follows:

- By the 2050s, freshwater availability in Central, South, East and South-east Asia, particularly in large river basins, is projected to decrease.
- Coastal areas, especially heavily populated megadelta regions in South, East and South-east Asia, will be greatly at risk due to increased flooding from the sea and in some megadeltas flooding from rivers.
- The pressures on natural resources and the environment associated with rapid urbanisation, industrialisation and economic development will be compounded by climate change.
- Sickness and deaths due to diarrhoeal disease primarily associated with floods and drought, due to changes in hydrological cycles, are expected to rise in East, South and South-east Asia.

In the case of India, up to 85 per cent of dry season flows of the great rivers of the Northern Indian Plain are supplied by Himalayan glaciers and snowfields. The 30 per cent reduction in meltwater forecast over the next 50 years has major implications for irrigated agriculture in the region. Most of India's agricultural land is rainfed and therefore very vulnerable. Variations in rainfall and increases in seasonally averaged temperatures could reduce crop yield by up to 70 per cent by the end of the century. These impacts are against a background of a need to increase food production by 5 million tonnes per year to keep pace with the predicted growth in



Source: WRI (2010a).

Figure 5.6 Emission intensity of economies in emission/GDP ratio, 2005

population to about 1.5 billion by 2030 (Challinor et al. 2006; Roy 2006; Stern 2006).

As in India, the losses in China are mainly concentrated in the agricultural sector. Drought will impact most heavily on regions of north and north-west China and there will be an extension of arid regions and an exacerbation of water scarcity. Drought in the north and floods in the south have already increased in frequency causing heavy economic losses (Erda and Ji 2006; Stern 2006).

Indonesia, being a tropical archipelago, is vulnerable to an increasing likelihood of droughts and floods. Livelihoods and food security will likely be affected by impacts on agriculture, fisheries and forestry, and parts of the country will suffer inundation (PEACE 2007).

5.2.2 Emission Intensity of Asian Economies

The emission intensity of Asian economies, that is the emissions/GDP ratio, varies greatly. As would be expected, developed countries are more efficient given that they have switched to lower-polluting fuels, have shed heavy industry and have well-developed infrastructures. China is much more emission intense than Indonesia and India, given that its economy is characterised by a high proportion of heavy industry and ongoing infrastructure development, as well as a reliance on coal for heat and electricity generation (see Figure 5.6).

Given the relative emission intensities, it follows that a reduction in GHG emissions by all countries, contributing to a peaking of CO_2e emissions in 2020 and a stabilisation of 550 parts per million by 2050,[5] is estimated to have a relatively greater negative impact on developing countries and on China's economy in particular. Under this scenario China suffers a cumulative loss of 5 per cent of GDP between 2005 and 2050 and India 3 per cent, while for the United States and EU the loss is only 1 per cent (OECD 2008b, p. 114).

5.2.3 Benefits of Mitigation

There are two major sources of economic and social benefits to Asian developing countries from global action to limit GHG emissions. The first is the amelioration in the direct impacts of climate change and the second is the generation of indirect benefits, or 'co-benefits', such as improvement in urban air quality that comes about as a result of climate change mitigation (OECD 2008a).

The economic costs of climate change that can be reduced by mitigation are extremely difficult to quantify, for several reasons. The nexus between temperature rise and deleterious physical consequences is rather speculative and, therefore, so is their costing. A large uncertainty surrounds the incidence of very costly catastrophes. Moreover, present costs are very sensitive to the discount rate, given that the release of GHGs today incurs costs well into the future. Finally some impacts are reversible while others are not, again imposing difficulties when it comes to pricing them.

Regional assessments of GDP impacts of global warming are over a large range but do suggest that Africa and South Asia are most heavily impacted. Nordhaus and Boyer (2000, p. 91) estimate (the authors emphasise the speculative nature of such estimates) that the negative impacts on GDP of a 2.5°C global warming will be the greatest in India (–5 per cent), with the highest incidence and cost of catastrophic impacts and high agricultural and heath costs incurred during this century. A summary of three studies for a temperature rise of 2.0–2.5°C relative to pre-industrial levels has the cost for Africa falling in the range −1 to −9 per cent of GDP, and for south and south-east Asia between +1 and −9. The GDP costs for China, the summary suggests, are between +2 and –5 per cent (OECD 2008a).

The timing of the costs and benefits of mitigation actions are very different. The costs are immediate, while the uncertain benefits are in the future. Given the high future growth rates in Asian developing countries, those countries would be expected to apply a high discount rate to the long-run benefits of action. The reluctance of developing Asian countries to participate is reinforced by the cost savings of abstaining, on the grounds of differentiated responsibility, while enjoying the benefits of mitigation generated by participants. The conclusion of an international agreement that includes Asian developing countries and binds them to a specific strategy (that would preferably include specific targets in the medium term) would reduce the propensity to take the free rider option.

5.2.4 Distributional Implications

A more comprehensive assessment of the economic impacts of a mitigation policy is obtained if the distributional aspects of a mitigation policy within a country's population are analysed. A rise in the price of carbon resulting from a carbon tax or a cap and trade scheme has been found to be progressive in India and China (Brenner et al. 2005; Datta 2008). Car ownership is confined to high-income households, while poorer households use less fossil fuel for heating, relying on biofuels and kerosene for cooking. In contrast, a price on carbon is found to be regressive in most developing countries because low-income households spend relatively more on energy-related products (OECD 2006). The extension of electrification to rural areas is linked to health improvements, income generation opportunities and higher educational attainment (see, for example, Kangawa and Nakata 2006, 2008). Carbon price increases could slow the uptake of electricity and poverty alleviation, unless tax revenues are redistributed from rich to poor (see Brenner et al. 2005 for such a proposal for China).

5.3 ISSUES OF EQUITY

Equity has always been a guiding principle in international agreements designed to curb GHG emissions. The United Nations Framework Convention on Climate Change (UNFCCC) (United Nations 1992, Article 3) required 'That parties should protect the climate system . . . on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities'. Only developed or Annex I countries were to commit to limit their emissions and protect and enhance carbon sinks (see Appendix 5.2 in this chapter for list of Annex I countries) (United Nations 1992, Article 4). The Kyoto Protocol, which put flesh on the bones of the Convention, required only these same countries (Annex B countries) to adopt specific limits on their 2008–12 emissions (United Nations 1998). The Bali Action Plan emphasised the application of the 'principle of common but differentiated responsibilities and respective capabilities, taking account of economic conditions and other relevant factors'; hence 'quantifiable emission limitation and reduction objectives' were agreed for developed countries, while only 'nationally appropriate actions', measurable and verifiable, were required of developing countries (UNFCCC 2007, p. 3).

The Group of 8, made up of countries with large economies, has come to recognise that emission targets that would avoid dangerous climate change are not possible without quantifiable cuts by developing countries, but still maintained the principle of differentiated responsibilities. A G8 commitment to a reduction target of 80 per cent by 2050 was accompanied by a statement of the need for emerging economies to undertake quantifiable, but unspecified, actions to collectively reduce their emissions, so that an overall target of least a 50 per cent reduction in global emissions could be achieved by 2050 (G8 2009, Paragraph 65).

The differentiation is continued in the Copenhagen Accord in which the mitigation actions by Non-Annex I countries are to be voluntary.

The differentiation between developed and developing countries in the Convention facilitated its ratification by almost all countries. Now that it has become obvious that developing countries must adopt quantifiable limits if dangerous climate change is to be avoided (see Appendix 5.3) the debate on equity issues has tended to intensify.

Developing countries have mounted three main arguments for preferential treatment in international agreements to reduce global emissions. These are:

1. The developed countries are responsible for most of the accumulated CO_2 in the atmosphere; the onus for cutting atmospheric greenhouse gas concentrations is therefore on them.
2. The developing countries should be allowed to continue to increase their per capita emissions, which are lower than those of the developed countries.
3. The developing countries' per capita incomes are relatively low and their growth should not be inhibited by requirements to reduce emissions.

Table 5.1 shows that the incomes of Indonesia, China and India all lie in the lower quartile. The per capita emissions of China and India are also relatively low but Indonesia's are higher due to deforestation. Apart from a few countries, including the United States, there are few with both high emission indicators and high socioeconomic indicators. Thus no one indicator is able to embody the multiple principles enunciated by the UNFCCC. The creation of indices that rank countries according

Table 5.1 Key country parameters, 2005

	GDP/Capita, US$, PPP[a]	CO_2/capita	% global CO_2e
US	42672	23.9	18.23
EU (27)	27642	10.9	13.76
China	4524	5.6	18.75
Indonesia[a]	3335	2.7	1.51
Indonesia[b]	3335	9.3	4.63
India	2416	1.7	4.84

Notes:
[a] Indonesia without LUC;
[b] Indonesia with LUC;
PPP = purchasing power parity in 2006 values at 2005 prices.

Source: WRI (2010a).

to composite indicators that attempt to capture their disparate national circumstances, could guide agreements in the inter-country allocation of mitigation effort.

To this end, a range of scenarios using different combinations of indicators is presented by Karousakis et al. (2008). All countries are ranked by different combinations of total contemporary GHGs, historical GHGs, GHGs per capita, GDP per capita and GHG/GDP, the latter being the emission intensity of the economy.

The two combinations of parameters (with equal weight) that give credible rankings are total GHGs, with either GDP per capita or GHG per capita. These combinations generate high scores for the United States and China and give India an intermediate score.[6] When total historical GHG emissions are included, rather than total contemporary GHG emissions, or when total GHGs are excluded, China has a very low index; such rankings are unrealistic in that no mitigation architecture will stand up without the active participation of China, the world's greatest emitter of GHGs.

While the development of indices does not solve the problem of how to allocate mitigation responsibilities between countries, it does nevertheless serve to inform the debate. Jacoby et al. (2008) show that simple rules for allocation lead to disproportionate burdens among countries and are incapable of dealing with the highly varying circumstances of countries. A benefit of the inclusion of socioeconomic and emissions intensity parameters in the discussion is to indicate which countries should have priority in receiving financial and/or technological assistance in making emissions reductions.

5.4 ASIAN PERSPECTIVES ON MITIGATION

This section concentrates on official responses on mitigation by China, India and Indonesia. China views as urgent the adoption by developed countries of a mid-term emission reduction target: 'All developed parties to the Convention shall commit to reduce their GHG emissions by at least 40 per cent below 1990 levels by 2020' (UNFCCC 2009a, p. 1). This target is at the extreme of the range of cuts (−25 to −40 per cent) recognised by the Bali Action Plan as being necessary to limit greenhouse gas emissions to 450 ppm (the 2°C limit) (UNFCCC 2007, Box 13.7). But China's position is realistic in the sense that it recognises that such a deep cut will be necessary to achieve such a target (see Appendix 5.3). China justifies its call on the grounds of historical responsibility by developed countries and the need for developing country economies to grow. Mitigation actions by developing countries will be determined by each country individually taking into account national capacities and circumstances. Moreover, China (UNFCCC 2009a, p. 8) invokes Article 3 of the convention, which states that developing countries shall 'provide such financial resources including the transfer of technology needed by the developing countries to meet the full incremental costs of implementing measures' (United Nations 1992, Article 3), to be achieved by developed countries making contributions of 0.5 to 1.00 per cent of GDP, in addition to existing overseas development assistance.

India's position on the division of responsibilities in climate change mitigation is the same as China's: developed countries (Annex I), individually or jointly, shall reduce their emissions by at least 40 per cent below the 1990 baseline by 2020. Developing country mitigation to be on a voluntary basis, the agreed full incremental costs to be met by developed countries (Ministry of Environment and Forests 2009).

Preparedness by China and India to reduce emissions below what they would be without mitigation was signalled by the G5[7] countries in 2008 as follows:

> We, on our part are committed to undertaking nationally appropriate mitigation and adaptation actions which also support sustainable development. We would increase the depth and range of these actions supported and enabled by financing technology and capacity-building with a view to achieving a deviation from business-as-usual (G5 2008, cited by VanBerkum et al. 2009, p. 16).

Indonesia has ratified the UNFCCC and the Kyoto Protocol, and as a non-Annex I country has been free of obligations to initiate mitigation measures. However, Indonesia acknowledges that as a major source of global GHGs from land clearing it needs technical and financial assistance in mitigation. To this end it has formalised an Indonesia–Australia Forest

Carbon Partnership (UNFCCC 2009b; Government of the Republic of Indonesia and Government of Australia 2008).

The United States will be influential in determining future international architectures for climate change post-Kyoto. It is therefore instructive to visit that country's draft protocol to the UNFCCC (2009c) in which it outlines a framework for mitigation actions by developed and developing countries. The United States continues to accept a differentiation of responsibility for mitigation between countries depending on their national circumstances. At the same time it does seek to commit developing countries; developing country Parties 'whose natural circumstances reflect greater responsibility or capability' would specify nationally appropriate mitigation actions from 2020 'that are quantified (for example, reductions from business-as-usual) and are consistent with the levels of ambition needed to contribute to meet the objectives of the Convention.' Each such party would formulate and submit a low carbon strategy for long-term emission reductions by 2050, consistent with the level of ambition needed to contribute to meeting the objective of the Convention (UNFCCC 2009c, p. 6).

The United States expects the private sector in both developed and developing countries to be the main source of funding rather than the public sector; that is, the carbon market would drive investment in mitigation. This is in contrast to the Chinese position that specifies that funds, as a proportion of GDP, be committed by developed country governments.

5.5 COMMITMENT BY COUNTRIES UNDER THE COPENHAGEN ACCORD

The Copenhagen climate change conference in December 2009 failed to produce a new international treaty with binding commitments to reduce greenhouse gas emissions. A loose agreement reached, the Copenhagen Accord, has yet to be signed-off by countries. The Accord requires countries to report their intended voluntary mitigation actions by the end of January 2010 (UNFCCC 2009d).

China did not commit to an emissions target. Instead it

> [W]ill endeavour to lower its CO_2 emissions per unit of GDP by 40–45 per cent by 2020 compared with 2005, increase the share of non-fossil fuels in primary energy consumption to around 15 per cent by 2020 and increase forest cover by 40 million ha and forest stock volume by 1.3 billion cubic metres by 2020 from the 2005 levels.

Likewise, India '[Will] endeavour to reduce emissions intensity of its GDP by 20–25 per cent by 2020 in comparison to the 2005 level.' In Indonesia's case the commitment is to achieve a 26 to 41 per cent CO_2e reduction by 2020 (UNFCCC 2010a). (See also the last paragraph under the section Policies of developing countries: the benefits of early action.)

These developing countries thus failed to meet the requirements of the United States for quantified reduction in emissions below BAU levels. Moreover, the bid by the United States to have reductions internationally monitored, reported and verified (MRV) also failed. The MRVs will be by the countries themselves, with international consultation and analysis of the reports. These failures will not add to the chances of the US Senate passing a bill to reduce US emissions by 17 per cent by 2020 on 2005 levels, which is its target submitted under the Accord (UNFCCC 2010b).

5.6 ASIAN COUNTRY PARTICIPATION IN FUTURE CLIMATE CHANGE ARCHITECTURES

The Kyoto Protocol has been a remarkable achievement in that it adopts a range of market-based instruments, including international emissions trading, that lower the costs of achieving emission reductions. However, judged on the grounds of the extent of actual international participation in measures to curb GHG emissions, the Protocol has failed. On a country basis, the top four emitters, China, the United States, Indonesia and Brazil, together responsible for about 50 per cent of global GHG emissions, are free from quantitative emissions targets. Much of the potential gains from trade have been lost and the cost of mitigation has been higher than it would have been with broader participation. Moreover, carbon intensive firms in countries with emission commitments may relocate to countries without commitments. This reduces the environmental benefits of the Protocol to participating countries and serves to create opposition to the adoption of climate change policy on competitiveness grounds (Aldy and Stavins 2008).

The analysis in this chapter supports the conclusion of other authors (Garnaut et al. 2008; Blandford et al. 2009) that developing countries and particularly the large fast-growing economies of Asia (Jotzo 2008) must take action to curb growth in GHGs if climate change is to be stabilised. A political perspective suggests that the United States will not join an international agreement because China has not signed up to a binding quantified target. In the future the key to participation of China and other developing countries will be the introduction of mechanisms that minimise economic costs and that continue to allow them to grow their economies. Such mechanisms are discussed in the next sections.

5.6.1 Minimising the Costs of Participation of Asian Developing Countries

The mitigation of global warming through the reduction of CO_2e emissions and the stabilisation of atmospheric CO_2e concentrations by the mid-twenty-first century will inevitably reduce global economic growth. The degree to which Asian countries will be impacted will depend on the depth of cuts in emissions that Asian countries take on, together with the energy and carbon intensity of their economies. Above, it was shown that the economies of China, India and Indonesia are emissions intensive and impacts on their economies of emissions reductions will inevitably be relatively greater than for developed economies. But even non-participating developing countries will be indirectly impacted as world growth slows. Non-participating countries could also face growth-restricting trade sanctions imposed by countries that have accepted binding commitments.[8]

Given the failure of the Copenhagen climate change conference to reach agreement on a new climate agreement, it is risky to predict the nature of the architecture that will emerge in the future. Nevertheless, factors that will decrease the effects of such an architecture on growth, for any given level of stabilisation adopted, include:

- Linkage of developing Asian countries to a market-based global architecture.
- Energy and emissions policies of developing countries.

5.6.2 Win–Win by Developing Country Participation

Two foundations of global architecture, both potentially very efficient in arriving at least-cost solutions in reducing carbon emissions, are 'cap and trade' and carbon taxes. Cap and trade schemes have the advantage of facilitating wealth transfer to participating low-cost countries (Olmstead 2008; Weiner 2008).

By developing countries accepting caps at or below a baseline of BAU, and trading emission permits below BAU, all participating nations gain (see Table 5.2).[9] The extent of the abatement by developing countries below BAU depends on the payments to do so offered by foreign corporations or governments; the developed countries and their corporations make these offers of payment for permits because their costs of abatement are relatively great. One reason for this cost difference is that developed countries would need to scrap coal fired plants to meet their caps, which is expensive, while growing developing countries can abate by installing new efficient systems (Frankel 2008).

Table 5.2 Win–Win from developing country cap at BAU, or below, and trade

Gains from developing country participation	Economic gains	Environmental gains
Gains for developing countries	Price received for sold permits > cost of cutting emissions	Co-benefits e.g. air quality improvement
Gains for developed Countries	Price paid for permits < cost of cutting emissions	Precludes leakage of emissions from non-members

Source: After Frankel (2008, Table 5.2.2).

If developing countries are to be fully compensated for their participation then the wealth transfer through emissions trading, to achieve a target of 50 per cent reduction in emissions by 2050, is very large. The importance of universal participation is twofold: costs are spread and the carbon leakage is reduced (carbon leakage to even a few free-riding nations could be substantial) (Jacoby et al. 2008).

Given the difficulty in forecasting GHG emissions there is a risk that fixed national caps could cause severe economic losses in rapidly growing developing countries.[10] Conversely, the sale of permits without any real reduction in emissions could occur where economic growth and hence emissions turn out to be well below BAU. An indexing approach that adjusts the cap for actual increases in GDP or GHG emissions above the projected values, and downwards for shortfalls, would lower the risks (Lutter 2000).

The Clean Development Mechanism (CDM) of the Kyoto Protocol has enabled investment and technology transfer to reduce emissions in India and China, in particular, the reductions being claimable against emission targets by Annex I countries. There is a strong consensus that the CDM will need to be improved or replaced to provide an adequate vehicle for developing country investment post-Kyoto.[11] A flaw in the CDM is that it provides a perverse incentive to ignore energy efficient investments by the host developing country; instead there are rewards for avoiding such commitments (Wara 2007; Wara and Victor 2008). If developing countries take on emission targets, reductions in GHG emissions resulting from the adoption of new technology will be directly claimable by the developing country itself: the perverse incentive is replaced by a genuine incentive to invest.[12]

5.6.3 Policies in Developing Countries: The Benefits of Early Action

Even if the developed countries were to unilaterally and immediately reduce their emissions to zero, stabilising global emissions would still likely be impossible.[13] The level at which concentrations of GHGs are eventually stabilised depends overwhelmingly on the actions of developing countries. But while the developed countries are relatively impotent they, and particularly the United States, need to play a leadership role in international negotiations for a post-Kyoto international climate regime that involves full participation by developing countries. 'Without evidence of serious action by the US, there will be no meaningful international agreement, and certainly not one that includes the key, rapidly-growing developing countries. Policy developments in the US can and should move in parallel with international negotiations' (Stavins 2009, p. 1).

The heaviest burden of action will fall on the BRIC (Brazil, Russia, India and China) group of countries, given their higher energy expenditure, and the reliance on carbon intensive fuels in the case of China and India. Given the long lead times to install improved energy infrastructure, near-future transfers of finance and technology are important to forestall energy-intensive growth. 'Without the technical means to reduce emissions while still enjoying the productive benefits of energy use, developing countries' decisions about whether to participate will be much more difficult, casting serious doubts on our ability to build an international coalition' (Blandford et al. 2009, p. 11).

Blandford et al. (2009) find that abatement costs are reduced massively for both developed and developing countries if key developing countries agree to the imposition of limits on their emissions at some future date, and follow up by taking account of such limits when making their long-lived capital investment decisions. Modelling by Bosetti at al. (2008, 2009) confirms this scenario; a delay by BRIC countries in responding to the need to make low carbon investment decisions is very costly for the world and developing countries alike, as the price of carbon would need to rise to very high levels to achieve stabilisation after delayed participation.

Bosetti et al. (2009) analyse China's actual and projected trends in green innovation and low-carbon technologies. China's policy is found to be anticipatory, its investment in nuclear power bringing in a large contribution by 2020. In addition total R&D spending is targeted at 2.5 per cent of GDP by 2020 compared with 1.5 per cent presently. The pattern of investment is compatible with the adoption of a mitigation policy by China by 2030 (Bosetti 2009, p. 7). It seems apparent, however, that limiting energy use and phasing out old power plants has not been motivated by China's climate change objectives but rather by concerns over energy security, energy costs and environmental factors such as air pollution (Downes 2004; Richerzhagen and Scholz 2008).

There is circumspection about China's efforts to reduce its carbon intensity rapidly between 2005 and 2020. Attempts to meet its 4 per cent annual reduction goal in energy intensity have met with limited success. In 2008, about an 8 per cent reduction in energy intensity had been achieved since the goal was launched in 2005. That leaves China only halfway to its 20 per cent target by 2010. Moreover much of the reduction was achieved in 2008 as a result of the global recession (Howes 2009, p. 420).[14] Thus the risk is exposed of accepting efficiency gains by China, rather than quantitative emission reductions, in a post-Kyoto architecture.

5.6.4 Prospects for Early Action in Indonesia

Emissions from deforestation amount to about 12 per cent (Le Quéré et al. 2009; Van der Werf et al. 2009) of global emissions and Indonesia's share of some 5 per cent of the global total, mostly due to deforestation, is an amount equal to more than a quarter of China's emissions.[15] An expeditious programme of reducing deforestation and forest degradation (REDD) has the potential to ease the overall burden of emission cuts on developing countries and thus on developing country growth.

A focus of the Bali climate change conference in December 2007 was on the development of measures to reduce deforestation and forest degradation (REDD). This was followed through in the Copenhagen Accord, which contains a collective agreement by developed countries to provide additional resources for climate change adaptation and mitigation in developing countries, including forestry, approaching US$30 billion for 2010–12, and rising to US$100 billion a year by 2020 (UNFCCC 2009d, Clause 8). At the same time, Australia, the United States, France, Japan, Norway and Britain pledged US$3.5 billion to support immediate steps to implement the Accord (Reuters 2009).

Effectively compensating for the loss of production and value adding will be no easy task, however. There are technical difficulties to be overcome in measuring carbon in tropical forests, in allowing for the possible impermanence of forest carbon sequestered, in estimating what would have been cleared in the absence of a scheme and in tracking leakage of deforestation to other sites or countries.

Even if an international market mechanism were established to compensate landowners, loggers, governments and industries for the loss of income involved, there is no guarantee that such a mechanism would be effective in reducing deforestation in Indonesia. The price of forestry carbon credits will depend heavily on the depth of cuts made by parties to a post-Kyoto agreement and the trading price of carbon in conserved forests will need to be sufficient to induce stakeholders to conserve, rather than convert, forests. Moreover, the price of forestry credits could well be discounted in the market because of the risks surrounding the permanence of such credits.[16] Given the relatively high income generated by palm oil in Indonesia, the price of carbon sequestered in forests in Brazil and Africa could well be cheaper than Indonesia's. Limits placed by parties committed to reductions in emissions on the level of use of forestry offsets in meeting those commitments could further curtail the effectiveness of an international market mechanism for sequestered carbon.[17]

The socioeconomic and political ramifications of reducing deforestation in Indonesia are also complex. By its very nature the exploitation of tropical forests invites corruption and illegal activities. Commentators have tended to minimise the difficulties of reducing deforestation, emphasising instead the low-cost availability of forestry offsets available from tropical countries (Garnaut 2008; Stern 2006). The author called for a reality check on REDD and argued for a non-market approach to REDD (Hunt 2009). Such an approach is now in place in the absence of a change in the CDM to include emissions reduction from REDD and the lack of mandated emissions cuts post-Kyoto.

Notwithstanding the manifest difficulties of securing sequestered carbon in standing forests in tropical developing countries, the Waxman-Markey Bill aimed at preventing international deforestation to achieve reductions equal to 10 per cent of US 2005 emissions by 2020. This equals 9 per cent of emissions from global deforestation and 26 per cent of emissions from Indonesian deforestation.

5.7 CONCLUSIONS

Large increases in temperature and potentially catastrophic climate change can only be avoided by developing countries committing to cuts in their GHG emissions. Asia is a very large emitter of GHGs and its contribution is rising rapidly. Therefore, Asian action is the key to climate change mitigation.

Most developed countries have already announced their intentions to cut their future emissions. The United States signalled that it wanted quantified cuts by developing countries that add up to achieving the objective of the Convention, which will be to stabilise greenhouse gas concentrations by the middle of the twenty-first century. However, following through on these intentions is contingent on complementary commitments by developing countries, and, in particular, Asian countries, and these so far have failed to materialise.

Rapidly growing Asian countries are naturally reluctant to forego present economic gains in exchange for benefits that are both uncertain and delayed for perhaps decades. A key to Asian country participation in the future is therefore an international climate agreement that minimises the impact on Asian growth. Enabling developing countries to sell reductions in emissions below their baseline has the potential to be a powerful incentive for developing country participation. As discussed, this arrangement can deliver wins for both developed and developing countries. Impacts of mitigation policies on the uptake of electricity and poverty alleviation in Asia would need to be tackled by internal policies that redistribute taxes.

Given the long lead time in achieving lower carbon economies, a second important element is the adoption of anticipatory investment policies by Asian countries. Technology and financial transfers to Asian developing countries will be most important for those not able to capture the benefits of trading, or that need assistance to bring deforestation under control.

Reduction in emissions from land-use change by just a few countries has the potential to ease the burden on all other countries. However, the complexity of the task has not been fully grasped by prominent commentators in developed countries. It will take time and considerable resources to tackle the technical, economic, political and social impediments to the prevention of the conversion of low value forests to high value agriculture.

The analysis in this chapter, together with other recent contributions, suggests that even a comprehensive international agreement to tackle climate change is unlikely to limit temperature increases to below 2°C by the end of the century. Ensuing climate change will have severe geophysical and socioeconomic impacts in South and South-east Asia. The importance of the development of adaption strategies for Asia is thus highlighted.

ENDNOTES

1. CO_2e takes account of the warming potential of all the major GHGs. Unless otherwise stated, 'GHGs' and 'emissions' are all in terms of CO_2e.
2. Developed countries are defined as Annex I countries subject to caps on emissions under the UNFCCC (United Nations 1992) (see Appendix 5.2 for a list of Annex I countries) and developing countries are defined as non-Annex I countries.
3. The correlation coefficient between 2005 CO_2e emissions per capita and 2005 GDP per capita for 190 countries is 0.85, while it is 0.93 for 18 countries of Asia (Bangladesh, Brunei, Darussalam, China, People's Republic, India, Indonesia, Korea North, Korea

South, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Taiwan, Thailand and Vietnam), source of data WRI (2009).

4. China's eleventh 5 year plan, covering the period 2006–10, calls for the country to increase the share of natural gas and other cleaner technologies in the country's energy mix and close several smaller coal-fired plants that were less efficient and heavy polluters. The government plans to remove 31 GW of coal generation in the next 3 years. Coal consists of roughly three-quarters of the power generation feedstock and the EIA forecasts it will maintain this market share through 2030. Natural gas will see the greatest percentage rise in installed electricity generation capacity over the next decade, but coal is expected to show the largest increase in absolute terms. There are several examples of China's effort to bring new natural gas-fired power stations online some in conjunction with LNG (liquid natural gas) terminals coming online, though the fuel will continue to play a marginal role in the power sector's fuel mix based on the higher cost of LNG and imported pipeline supplies versus coal (IEA 2009).
5. Which Appendix C suggests would have a probability of 50 per cent of limiting a global temperature rise by the end of the century to 3°C.
6. It has already been demonstrated (endnote 3) that GDP per capita and GHGs per capita are highly correlated, so that a combination of these together in index creation is an unnecessary complication.
7. The G5 is made up of Brazil, China, India, Mexico and South Africa, presently responsible for 41 per cent of developing country (non-Annex I) CO_2e emissions, with land-use change.
8. For example the Waxman-Markey Bill HR 2454, which passed the US House of Representatives, includes a provision to impose border taxes on carbon intensive goods from non-participating countries.
9. Bosetti et al. (2008) show that the substantial costs to developed countries in meeting targets are reduced if developing countries are allowed to trade from their BAU baseline. Weiner (2008) suggests that developing countries could accept targets less than BAU that reflect the climate protection and other co-benefits of joining the international cap and trade architecture. Bosetti et al. (2009) note that the choice of a BAU baseline is not an obvious one in that the fast growing developing countries with large investment possibilities might incorporate energy and carbon-efficient measures into their baselines.
10. Garnaut et al. (2008) illustrate the difficulty of accurate forecasting by reference to the forecasts of GDP by the World Bank and of CO_2e emissions from fossil fuels by the IEA.
11. See, for example, Keeler and Thompson (2008) and Victor (2008).
12. Another imitation of the CDM of the Kyoto Protocol, with relevance to Indonesia, is that it does not allow the purchase of offsets generated by the reduction in deforestation or forests degradation, being limited to offsets for afforestation and reforestation (see for example Hunt 2009).
13. Blandford et al. (2009) suggests stabilisation at 550 ppm CO_2e will be infeasible unless pessimistic economic growth follows the global financial crisis (GFC). This finding supports the conclusion derived in Appendix 5.3 of this chapter on the feasibility of attaining stabilisation targets.
14. Even if China reduced its CO_2 intensity of GDP by about 50 per cent in 2020, compared with 2005, emissions in 2020 will still be about 40 per cent higher than in 2005 because of rapid economic growth (He et al. 2009).
15. The accuracy of all deforestation estimates is subject to the caveats of Appendix 5.1.
16. The market price of CO_2e sequestered by afforestation/reforestation in the CDM is discounted heavily because they are temporary and must be replaced (Hunt 2009).
17. For example, the Waxman-Markey Bill puts limits on the use of international offsets by US firms.
18. See also WRI, 2010b. A note on CO_2 emissions from land use change and forestry, at http://cait.wri.org/cait.php?page =background&from=yearly&mode=view.

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APPENDIX 5.1 EMISSIONS FROM LAND-USE CHANGE AND FORESTRY

There is a great deal of uncertainty in the estimation of GHG emissions from land-use change and forestry (LUCF) caused by deforestation in tropical Asia (principally Indonesia) and South America (principally Brazil), in a particular year (WRI 2009). The likely errors stem from the estimation of biomass lost per hectare through land conversion as well as from errors in estimation of forest hectares converted (Houghton 2005).

The variability in emissions from land-use change is underlined in the case of Indonesia where Murdiyarso and Adiningsih (2007) estimate CO_2 emissions from forest fires were 5300 Mt in 1997, compared with 2560 Mt for 2003 estimated by Houghton (2003). Moreover, the WRI (2010a) estimates for LUC are much lower than for WRI (2009).[1] The author adopts OECD (2008b) LUCF estimates for 2005 and 2020 (12 per cent of total emissions) for the modelling of world emissions and the emissions cuts required by non-Annex I countries in 2020, the results of which are presented in Figures A5.1 and A5.2 and Appendix Table A5.3.

APPENDIX 5.2 ANNEX I COUNTRIES

Table A5.1 Annex I countries

Australia	Austria	Belarus*
Belgium	Bulgaria*	Canada
Czechoslovakia*	Denmark	European Economic Community
Estonia*	Finland	France
Germany	Greece	Hungary*
Iceland	Ireland	Italy
Japan	Latvia*	Lithuania*
Luxembourg	Netherlands	New Zealand
Norway	Poland*	Portugal
Romania*	Russian Federation*	Spain
Sweden	Switzerland	Turkey
Ukraine*	United Kingdom of Great Britain and Northern Ireland	United States of America

Note:
* Countries that are undergoing the process of transition to a market economy.
Annex B, subject to emissions limitations under the Kyoto Protocol, is made up of Annex I countries plus Liechtenstein, Monaco, Slovakia and Slovenia (United Nations 1998).

Source: United Nations (1992).

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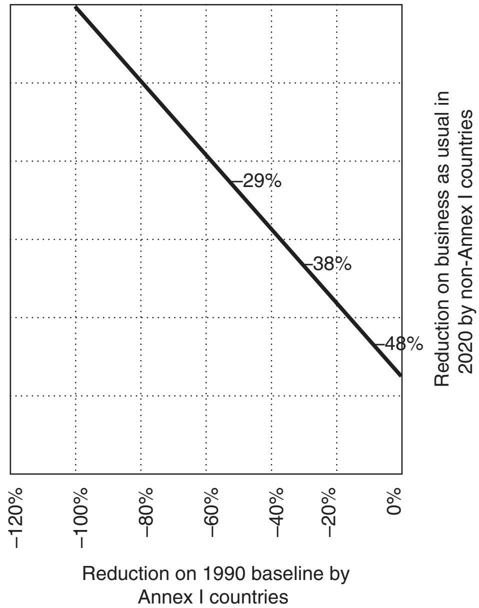


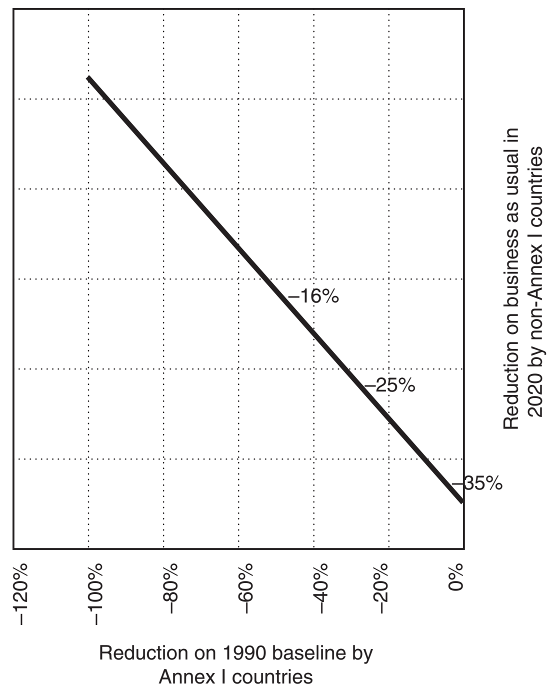
Source: Author's modelling. For probability of temperature rise for stabilisation targets, see Meinshausen et al. 2009.

Figure A5.1 Reduction in CO_2e emissions by Annex I and non-Annex I countries to achieve a 450 ppm trajectory

APPENDIX 5.3 GLOBAL MITIGATION IMPERATIVES AND REALITIES

Impacts of increased GHG concentrations in the atmosphere are slow to become apparent. Even after their stabilisation warming and sea-level rise will continue for centuries. Large reductions from current levels of emissions are required to stabilise the climate. The lower the level of stabilisation, the sooner cuts in emissions need to begin, and the deeper the long-term emission reduction needed. Delays in making cuts may lead to overshooting in targets for GHG concentrations, with deleterious social and environmental consequences from irreversible change.

The Bali Action Plan (UNFCCC 2008, p. 3) in responding to the IPCC's Fourth Assessment Report (IPCC 2007) acknowledged that 'deep cuts in global emissions will be required to achieve the ultimate objective of the Convention . . . and that delay in reducing emissions significantly



Source: Author's modelling. For probability of temperature rise for stabilisation targets, see Meinshausen et al. 2009.

Figure A5.2 Reduction in CO_2e emissions by Annex I and non-Annex I countries to achieve a 550 ppm trajectory

constrains opportunities to achieve lower stabilisation levels and increases the risk of more severe climate change impacts.'

The IPCC's Fourth Assessment report, Working Group III, summarised the literature (IPCC 2007, Box 13.7) on the required emissions reduction ranges in Annex I and non-Annex I countries to achieve GHG concentration stabilisation levels. The summary indicates that Annex I countries as a group would need to reduce their emissions to below 1990 levels in 2020 by 25 per cent to 40 per cent for stabilisation at 450 ppm, and 10 to 30 per cent for 550 ppm, even while emissions from non-Annex I countries deviate substantially from their baseline in the case of the 450 ppm target.

A5.3.1 Cuts Required to Stabilise GHG Concentrations

The authors of Box 13.7 in IPCC (2007) (den Elzen and Höhne 2008, p. 250) have since conceded that: 'The current slow pace in climate policy and the steady increase in global emissions make it almost impossible to reach a relatively low global emissions levels in 2020 needed to meet the 450 ppm CO_2e'. An analysis of actual mitigation commitments as at mid-2009 made by 100 developed and developing countries leads Rojelg et al. (2009, p. 2) to conclude that 'unless there is a major improvement in national commitments to reducing GHGs we see no chance of staying below 2°C or 1.5°C.'

This section supports this conclusion of den Elzen and Höhne (2008) and Rogelj et al. (2009), and goes further in suggesting that the feasibility of achieving cuts to stabilise CO_2e concentrations to 550 ppm is also in doubt.

The results of modelling the cuts needed to limit CO_2e concentrations to 450 ppm, which would likely lead to temperature increases less than 2°C in the twenty-first century and to 550 ppm, which would likely lead to temperature increases greater than 2°C in the twenty-first century, are shown in Figures A5.1 and A5.2. These figures show the reduction required by non-Annex 1 (developing) countries for a given reduction by Annex I (developed) countries to achieve a 450 ppm emissions trajectory and a 550 ppm trajectory respectively. In Figure A5.2, even large percentage cuts on 1990 CO_2e emissions by Annex I countries (Table A5.1), which are highly unlikely, require significant reductions in 2020 BAU emissions by non-Annex I countries. Figure A5.2 suggests that relaxing the target to 550 ppm still requires a large cut on non-Annex BAU by 2020 if Annex I countries adopted a lesser average cut of 20 per cent.

A5.3.2 Mitigation Commitments by Developed Countries and Implications for GHG Stabilisation

Even if Annex I countries reduced their emissions collectively by 20 percent, non-Annex I countries would need to reduce emissions by 25 per cent on BAU by 2020 to achieve stabilisation at 550 ppm (see Figure A5.2). A result of modelling that reinforces the importance of developing country participation in meeting stabilisation targets is that even if developed countries reduced their collective emissions to zero in 2020, in the absence of a contribution by developing countries, the 450 stabilisation target would just be complied with. In Table A5.3 (row 6) the cut required to achieve stabilisation at 450 ppm is 18 600 Mt CO_2e, which is about equal to the total Annex I country emissions in 1990 (row 1). Indeed,

Table A5.2 World CO_2e emissions actual (1990–2005) and projected (2020) under BAU

	1990	1995	2000	2005	2020	Average annual rate of change average annual 2005–20
WORLD wolucf	34 392	35 345	39 051	43 476	53 600	1.55
Annex I	18 582	18 216	18 091	18 624	19 764	0.41
Non-Annex I	15 810	17 129	20 960	24 852	33 836	2.41
LUCF	4 000	3 900	5 400	5 700	5 000	–0.82
Non-Annex I wlucf	19 810	21 029	26 360	30 552	38 836	1.81
World wlucf	38 392	39 245	44 451	49 176	58 600	1.28

Notes:
LUCF = land-use change and forestry;
wolucf = without land-use change and forestry;
wlucf = with land-use change and forestry.

Sources: Years 1990–2005 World, Annex I and Non-Annex I: IEA (2008a); Year 2020 World: OECD (2008b); Year 2020 Annex I and Non-Annex I distribution: author's estimates based on IEA (2008b); Years 1990–2020 LUCF: OECD (2008b).

as Blandford at al. (2009) confirm, the level of stabilisation that can be achieved depends entirely on the actions of non-Annex I countries.

Another way of assessing the emissions curbs required by non-Annex I countries is to consider growth in emissions to 2020 compared with 2005. Under BAU, their collective emissions are projected to grow by 43 per cent over this period (see Table A5.2); but achieving the 550 ppm target (given a cut of 20 per cent on 1990 level by Annex I countries) implies that non-Annex I countries will cut emissions by 5 per cent by 2020 compared with 2005.

Garnaut et al. (2008), in a sophisticated analysis, reach the conclusion that, if Annex I countries cut by 30 per cent on 1990 levels by 2020, a deep (26 per cent) will be required by non-Annex I countries to their BAU emissions in 2020 to achieve stabilisation at 550 ppm. The analysis in this chapter suggests a similar result; for a 30 per cent cut by developed countries, non-Annex I countries would need to reduce their BAU emissions by 21 per cent. (See Table A5.3 for the detail of a 30 per cent cut by Annex I countries.) This BAU cut by non-Annex I countries in 2020 translates to a mere 1 per cent increase in emissions in 2020 compared with 2005.

Table A5.3 Estimate of cuts required in CO_2e emissions to achieve 2020 stabilisation targets

1.	Annex I countries 1990 Mt (from Table A5.2)	18 582	
2.	Non-Annex I countries 2005 Mt (from Table A5.2)	30 552	
3.	Non-Annex I countries 2020 projection wlucf Mt (from Table A5.2)	38 836	
4.	World 2020 projection wlucf Mt (from Table A5.2)	58 600	
		450 ppm CO_2e[a]	550 ppm CO_2e[b]
5.	World 2020 targets Mt	40 000	45 000
6.	Cut required by 2020 Mt (5–4)	–18 600	–13 600
7.	Cut of 30% on 1990 levels by Annex I countries by 2020 Mt	–5 575	–5 575
8.	Cut required by non-Annex I countries by 2020 Mt (6–7)	–13 025	–8 025
9.	Non-Annex I after cuts in 2020 Mt (3+8)	25 811	30 811
10.	Change on non-Annex I countries BAU by 2020 % (8/3*100)	–34	–21

Notes:

[a] Limiting the atmospheric concentration of CO_2e to 450 ppm, achieved by a world target of 40 000 Mt CO_2e in 2020, gives a probability of exceeding a 2°C rise in temperature throughout the twenty-first century of 19–56%, i.e. the probability of staying within 2°C is 'more likely than not' (Meinshausen et al. 2009, Figure S1c).

[b] Limiting the atmospheric concentration of CO_2e to 550 ppm, achieved by a world target of 45 000 Mt CO_2e in 2020, gives a probability of exceeding a 2°C rise in temperature throughout the twenty-first century of 30–70%, i.e. the probability of staying within 2°C is 'less likely than not' (Meinshausen et al. 2009, Figure S1c).

wlucf = with land-use change and forestry.